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ABSTRACT

Written for remedial/developmental students without algebraic skills, these three arithmetic modules for electronics cover measure, formulas, and pythagorean theorem. The self-paced modules incorporate use of calculators. With this aid the level of difficulty of comprehension is approximately seventh grade. Module 1, Measure, covers nine topics: powers of 10, metric words, basic electronic measure, basic change, multiply powers, more power multiplication, division with powers, changing metrics, and changing measure. Module 2, Formulas, covers four topics: changing formulas, electrical power, Ohms law, and time and frequency formulas. Module 3, Pythagorean Theorem, covers three topics: square root (using calculator), length of hypotenuse, and length of sides. Answers are provided for all exercises/problems. (YLB)

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ED197120

THREE MODULES FOR ELECTRONICS MATHEMATICS

(Remedial/Developmental)

The three arithmetic modules for electronics--measure, formulas, Pythagorean theorem--were written for remedial/development students without algebraic skills. The modules could be used as an integral part of or as an addendum to an arithmetic program. The modules could also be made available in a learning assistance center for students lacking manipulative skills required for measure and formulas.

Since the modules cover electronic mathematics excluding trigonometry, students could be admitted to basic electronic courses with sufficient skills to permit simultaneous enrollment in electronic mathematics. This arrangement would shorten the time sequence by a semester.

The modules incorporate the use of calculators particularly for finding square root. With this aid the level of difficulty of comprehension is approximately seventh grade.

The modules were field tested with a limited number of prospective and non-prospective electronic students. These students were familiar with a remedial arithmetic program. The tested students mastered the required skills with ease.

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3 ARITHMETIC MODULES FOR ELECTRONICS

Module 1: Measure

- M-1 Powers of 10
- M-2 Metric words
- M-3 Basic electronic measure
- M-4 Basic change
- M-5 Multiply powers
- M-6 More power multiplication
- M-7 Division with powers
- M-8 Changing metrics
- M-9 Changing measure

Module 2: Formulas

- F-1 Changing formulas
- F-2 Electrical power
- F-3 Ohms law
- F-4 Time and frequency formulas

Module 3: Pythagorean theorem

- P-1 Square root (using calculator)
- P-2 Length of hypotenuse
- P-3 Length of sides

ARITHMETIC SELF-PACED FOR ELECTRONICS

How to use:

Look at page, then if

- do not know WELL, dig in.
↖ work, work
- think know, try hard problems.
(If not easy, do whole page.)
- SURE know, go to next page.

Work problems before you look at answers.

WARNING: Each page builds on pages before.
Miss a step and you are in for TROUBLE.

METRIC-TO-METRIC

M-1

Powers of 10

$$10 \times 10 \times 10 = 1000 = 10^3$$

↓ ↓ ↓
1 2 3

3 is called a power
We say 10 to the 3rd power.

(answers below)

_____ 1) Write using a power: $10 \times 10 \times 10 \times 10 \times 10 \times 10$

_____ 2) #1 says 10 to the

_____ 3) Write using a power: 1,000,000,000

_____ 4) #3 says 10 to the

_____ 5) Write out 10^{12} as a number.

$$10 = 10^1$$

$$1 = 10^0$$

(Reason later)

Answers: (1) 10^6 (2) 6th power (3) 10^9 (4) 9th power (5) 1,000,000,000,000

$$.01 = \frac{1}{100} = \frac{1}{10^2} = 10^{-2} = 10 \text{ to the negative 2nd power.}$$

_____ 1) $.1 = \frac{1}{\text{ }} = \frac{1}{10^{\text{ }}} = 10^{\text{ }}$

_____ 2) $.001 = \frac{1}{\text{ }} = \frac{1}{10^{\text{ }}} = 10^{\text{ }}$

_____ 3) $\text{ } = \frac{1}{1,000,000} = \frac{1}{10^{\text{ }}} = 10^{\text{ }}$

_____ 4) $\text{ } = \frac{1}{1,000,000,000} = \frac{1}{10^{\text{ }}} = 10^{\text{ }}$

WARNING: 10^2 > count o's 10^{-2} > count decimal places

Answers: (1) $\frac{1}{10}, \frac{1}{10^1}, 10^{-1}$ (2) $\frac{1}{1000}, \frac{1}{10^3}, 10^{-3}$ (3) $.000,001, \frac{1}{10^6}, 10^{-6}$

(4) $.000,000,001, \frac{1}{10^9}, 10^{-9}$

METRIC WORDS

Fill in blanks

(answers below)

M-2

	Prefix	Symbol	Value	Power of 10	ten to the _____ power
	atto	a	0.000,000,000,000,000,001	10^{-18}	negative 18th
1	femto	f	0.000,000,000,000,001	-----	-----
2	pico (micromicro)	$\begin{matrix} p \\ \mu \mu \end{matrix}$	-----	10^{-12}	-----
3	nano (millimicro)	$\begin{matrix} n \\ (m \mu) \end{matrix}$	-----	10^{-9}	-----
4	micro	$\begin{matrix} \mu \\ \swarrow \text{Greek} \\ m \end{matrix}$	0.000,001	-----	-----
5	milli	m	0.001	-----	-----
6	centi	c	-----	10^{-2}	-----
7	deci	d	-----	10^{-1}	-----
8	(unit)		1	10^0	zero power
9	deka	D	-----	10^1	-----
10	hecto	h	100	-----	-----
11	kilo	k	1,000	-----	-----
12	mega	M	-----	10^6	-----
13	giga	G	-----	10^9	-----
14	tera	T	-----	10^{12}	-----

(1) 10^{-15} ; negative 15th (2) 0.000,000,000,001 negative 12th (3) 0.000,000,001 negative 9th (4) 10^{-6} negative 6th (5) 10^{-3} negative 3rd (6) .01 negative 2nd (7) .1 negative 1st (9) 10; 1st (10) 10^2 ; 2nd (11) 10^3 , 3rd (12) 1,000,000; 6th (13) 1,000,000,000; 9th (14) 1,000,000,000,000; 12th

BASIC ELECTRONIC MEASURE

M-3

Use page M-2 and fill in empty places. (answers below)

	Measure	Measure Symbol	Power and Measure Symbol	Word	Metric Symbol and Measure Symbol
	1000 watts	W	10^3W	kilowatt	kW
1	0.001 watt				
2	0.000,001 volt	V			
3				millivolt	
4				kilovolt	
5	1000 hertz	Hz			
6			10^9Hz		
7	1,000,000 ohms	Ω		megohm	
8			$10^3\Omega$		
9	0.000,001 amperes	A			
10	0.001 henry	H			
11	1,000,000 farads	F			
12				picofarad	
13	0.000,000,001 seconds	sec			

(1) W; $10^{-3}W$; milliwatt; mW (2) $10^{-6}V$; microvolt; μV (3) 0.001 volt; V; $10^{-3}V$; mV
 (4) 1000 volts; V; 10^3V ; kV (5) 10^3Hz ; kilohertz; kHz (6) 1,000,000,000 hertz;
 Hz; gigahertz; GHz (7) $10^6\Omega$; M Ω (8) 1000 ohms, Ω , kilohm, k Ω (9) $10^{-6}A$,
 microampere, μA (10) $10^{-3}H$, millihenry, mH (11) 10^6F megafarad, MF
 (12) 0.000,000,000,001 farads, F, 10^{-12} , pF (13) 10^{-9} sec; nanosecond, nsec

BASIC CHANGE

For Electronics } $10^{-18}, 10^{-15}, 10^{-12}, 10^{-9}, 10^{-6}, 10^{-3}, 10^0$, and +'s

M-4

Fill in empty places

(answers below)

	Measure	Number, Power, Symbol	Number, Word	Number and Measure Symbol
	3000 watts (think: $3000 = 3 \times 1000$)	$3 \times 10^3 W$	3 kilowatts	3kW
1	5000 ohms			
2	0.002 amperes			
3				$7\mu A$
4	8,000,000,000,000 farad			
5			4 microseconds	
6				2.5kV
7				3.9M Ω
8		$1.3 \times 10^{-3} H$		
9		$.3 \times 10^{-3} A$		
10				6.4 nsec

Answers will be worked from problem.

(1) $5000 = 5 \times 1000$; $5 \times 10^3 \Omega$; 5 kilohms; 5k Ω (2) $.002 = 2 \times .001$; $2 \times 10^{-3} A$; 2 milliamperes; 2mA (3) $7\mu A = 7$ microamperes = $7 \times 10^{-6} A$; $7 \times .000001 A = .000007$ amperes (4) $8,000,000,000,000 = 8 \times 1,000,000,000,000$; $8 \times 10^{12} F = 8$ terafarads = 8TF (5) 4 microseconds = $4\mu sec = 4 \times 10^{-6} sec = 4 \times .000001 sec = .000004$ seconds (6) $2.5kV = 2.5$ kilovolts = $2.5 \times 10^3 V = 2.5 \times 1000V = 2500V$ (7) $3.9M\Omega = 3.9$ megohms = $3.9 \times 10^6 \Omega = 3.9 \times 1,000,000\Omega = 3,900,000\Omega$ (8) $1.3 \times 10^{-3} H = 1.3 \times .001H = .0013$ henrys = 1.3 millihenrys = 1.3mH (9) $.3 \times 10^{-3} A = .3 \times .001A = .0003$ amperes = .3 milliamperes; = .3mA (10) 6.4 nanoseconds = $6.4 \times 10^{-9} sec = 6.4 \times .000,000,001 sec = .000,000,0064$ seconds

MULTIPLY POWERS

M-5

We know: $100 \times 1000 = 100,000$
 $\downarrow \quad \downarrow$
 $10^2 \times 10^3 = 10^5$ or $10^2 \times 10^3 = 10^{2+3} = 10^5$

Rule: To multiply ---> Add powers

Change to powers and multiply:

_____ 1) $10,000 \times 1,000,000$

_____ 2) $1,000,000,000,000 \times 1,000,000,000$

_____ 3) 10×1000

Now we see reason for $1 = 10^0$: $1 \times 100 = 10^0 \times 10^2 = 10^{0+2} = 10^2$

Watch this: $.01 \times .0001 = .000001$
 $\downarrow \quad \downarrow$
 $10^{-2} \times 10^{-4} = 10^{-6}$ or $10^{-2} \times 10^{-4} = 10^{-2-4} = 10^{-6}$

Remember: You are adding -2 and -4

Rule: To add negative numbers --->
Add numbers and use minus sign.

_____ 4) $0.000,000,001 \times 0.001$

_____ 5) $0.000,000,000,001 \times 0.000,001$

_____ 6) 0.1×0.1

_____ 7) $0.000,001 \times 0.1$

(1) $10^4 \times 10^6 = 10^{4+6} = 10^{10}$ (2) $10^{12} \times 10^9 = 10^{12+9} = 10^{21}$
(3) $10^1 \times 10^3 = 10^{1+3} = 10^4$ (4) $10^{-9} \times 10^{-3} = 10^{-9-3} = 10^{-12}$
(5) $10^{-12} \times 10^{-6} = 10^{-12-6} = 10^{-18}$ (6) $10^{-1} \times 10^{-1} = 10^{-1-1} = 10^{-2}$
(7) $10^{-6} \times 10^{-1} = 10^{-6-1} = 10^{-7}$

$\begin{array}{rcl} .00001 \times 100 & = & .001\cancel{00} \\ \downarrow -5 & \quad \downarrow 2 & \\ 10^{-5} \times 10^2 & = & 10^{-5+2} = 10^{-3} \end{array}$	$\begin{array}{rcl} .01 \times 100,000 & = & 1000.\cancel{00} \\ \downarrow -2 & \quad \downarrow 5 & \\ 10^{-2} \times 10^5 & = & 10^{-2+5} = 10^3 \end{array}$
---	--

Rule: To add numbers with unlike signs:
 (1) Subtract numbers
 (2) Use sign of larger* number

*Note: The number that is larger without signs.

Change to powers and multiply:

_____ 1) 1,000,000 x 0.000,000,001

_____ 2) 0.000,000,001 x 1,000,000

_____ 3) 1,000,000,000 x 0.000,000,001

_____ 4) micro x kilo

_____ 5) milli x pico

_____ 6) mega x nano

_____ 7) pico x tera

_____ 8) micro x kilo

(1) $10^6 \times 10^{-9} = 10^{6-9} = 10^{-3}$ (2) $10^{-9} \times 10^6 = 10^{-9+6} = 10^{-3}$

(3) $10^9 \times 10^{-9} = 10^{9-9} = 10^0 = 1$ (4) $10^{-6} \times 10^3 = 10^{-6+3} = 10^{-3}$

(5) $10^{-3} \times 10^{-12} = 10^{-3-12} = 10^{-15}$ (6) $10^6 \times 10^{-9} = 10^{6-9} = 10^{-3}$

(7) $10^{-12} \times 10^{12} = 10^{-12+12} = 10^0 = 1$ (8) $10^{-6} \times 10^3 = 10^{-6+3} = 10^{-3}$

DIVISION WITH POWERS

M-7

Remember $\frac{1}{1000}$ is a division problem. [1000 is denominator]

$$\frac{1}{10^3} = \frac{1}{1000} = 1000 \overline{1.000} = .001 = 10^{-3} \text{ so } \boxed{\frac{1}{10^3} = 10^{-3}}$$

$$\frac{1}{10^{-3}} = \frac{1}{.001} = .001 \overline{1.000} = 1000 = 10^3 \text{ so } \boxed{\frac{1}{10^{-3}} = 10^3}$$

Rule: To divide 10 with powers →
 1) Change sign of power in denominator
 2) Multiply

Example: $\frac{10^3}{10^5} = 10^{3-5} = 10^{-2}$ *long way:* $\frac{10^3}{10^5} = \frac{10 \times 10 \times 10}{10 \times 10 \times 10 \times 10 \times 10} = \frac{1}{10^2} = 10^{-2}$

_____ 1) $\frac{10^3}{10^{-3}}$

_____ 2) $\frac{10^5}{10^{-3}}$

_____ 3) $\frac{10^3}{10^{-5}}$

_____ 4) $\frac{10^{-5}}{10^{-3}}$

_____ 5) $\frac{10^{-5}}{10^3}$

_____ 6) $\frac{10^{-6}}{10^6}$

_____ 7) $\frac{10^0}{10^9}$

_____ 8) micro $\div$ kilo denominator

_____ 9) milli $\div$ micro

(1) $10^{3+3} = 10^6$ (2) $10^{5+3} = 10^8$ (3) $10^{3+5} = 10^8$ (4) $10^{-5+3} = 10^{-2}$

(5) $10^{-5-3} = 10^{-8}$ (6) $10^{-6-6} = 10^{-12}$ (7) $10^{0-9} = 10^{-9}$

(8) $\frac{10^{-6}}{10^3} = 10^{-6-3} = 10^{-9}$ (9) $\frac{10^{-3}}{10^{-6}} = 10^{-3+6} = 10^3$

CHANGING METRICS

M-8

IMPORTANT
METHOD!!!

Change 6 to some number x 3

$$6 = \square \times 3$$

$$\frac{6}{3} = \square$$

$$2 = \square$$

$$\text{So } 6 = 2 \times 3$$

- Step 1: Write problem
- Step 2: Write powers
- Step 3: Divide

Problem: Change 1 kilo to megas

(1) 1 kilo = $\square$ megas

(2) 10^3 = $\square$ 10^6

(3) $\frac{10^3}{10^6} = 10^{3-6} = 10^{-3} = \square$

So 1 kilo = 10^{-3} mega
or (.001 mega)

Change:

_____ 1) 1 kilo to micro

_____ 2) 1 giga to kilo

_____ 3) 1 milli to mega

_____ 4) 1 milli to nano

_____ 5) 1 nano to pico

_____ 6) 1 mega to micro

(1) 1 kilo = $\square$ micro
 $10^3 = \square 10^{-6}$
 $\frac{10^3}{10^{-6}} = 10^{3+6} = 10^9 = \square$
So 1 kilo = 10^9 micro

(2) 1 giga = $\square$ kilo
 $10^9 = \square 10^3$
 $\frac{10^9}{10^3} = 10^{9-3} = 10^6 = \square$
So 1 giga = 10^6 kilo

(3) 1 milli = $\square$ mega
 $10^{-3} = \square 10^6$
 $\frac{10^{-3}}{10^6} = 10^{-3-6} = 10^{-9} = \square$
So 1 milli = 10^{-9} mega

(4) 1 milli = $\square$ nano
 $10^{-3} = \square 10^{-9}$
 $\frac{10^{-3}}{10^{-9}} = 10^{-3+9} = 10^6 = \square$
So 1 milli = 10^6 nano
(or = 1,000,000n)

(5) 1 nano = $\square$ pico
 $10^{-9} = \square 10^{-12}$
 $\frac{10^{-9}}{10^{-12}} = 10^{-9+12} = 10^3 = \square$
So 1 nano = 10^3 pico
(or = 1000 pico)

(6) 1 mega = $\square$ micro
 $10^6 = \square 10^{-6}$
 $\frac{10^6}{10^{-6}} = 10^{6+6} = 10^{12} = \square$
So 1 mega = 10^{12} micro
(or 1,000,000,000,000μ)

CHANGING MEASURE

M-9

Use steps on page M-8

Examples:

Change 2500 kilohertz to megahertz

$$\begin{aligned}
 2500 & \times 10^3 = \square 10^6 \quad \text{Change sign for division} \\
 2.5 \times 10^3 & \times 10^3 \times 10^{-6} = \square \\
 \text{Note: } 3 + 3 - 6 &= 0 \text{ and } 10^0 = 1 \\
 2.5 &= \square
 \end{aligned}$$

So 2500 kilohertz = 2.5 megahertz

Change .0045 microfarads to picofarads

$$\begin{aligned}
 .0045 & \times 10^{-6} = \square 10^{-12} \\
 4.5 \times .001 & \quad \text{Change sign for division} \\
 4.5 \times 10^{-3} & \times 10^{-6} \times 10^{12} = \square \\
 4.5 \times 10^3 &= \square \quad \text{[Note } -3-6+12=3] \\
 \text{So } .0045\mu\text{F} &= 4.5 \times 10^3 \text{ pF}
 \end{aligned}$$

Make the changes. Answers below. **WARNING:** Work until you can almost do in your head.

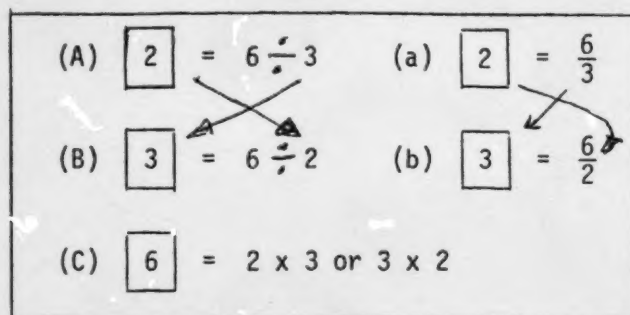
- 1) 4300V = _____ mV _____ μ V _____ kV
- 2) .685A = _____ mA _____ μ A
- 3) 135V = _____ kV _____ μ V _____ mV
- 4) 1250mA = _____ μ A _____ A
- 5) 3300 Ω = _____ k Ω _____ M Ω
- 6) 500mF = _____ F _____ pF
- 7) 2000pF = _____ F _____ μ F
- 8) 0.5mH = _____ H _____ μ H
- 9) 3400W = _____ kW _____ mW _____ μ W
- 10) 0.3 sec = _____ msec _____ μ sec
- 11) 1320kHz = _____ MHz _____ Hz
- 12) 4 k Ω = _____ Ω _____ M Ω

- (1) $4.3 \times 10^6 \text{ mV}$; $4.3 \times 10^9 \mu\text{V}$; 4.3kV (2) (Use $685 \times .001$) 685mA; $685 \times 10^3 \mu\text{A}$
 (3) (Use $.135 \times 1000$) .135kV; $.135 \times 10^9 \mu\text{V}$; $.135 \times 10^6 \text{ mV}$ (4) (Use 1.25×10^3) $1.25 \times 10^6 \mu\text{A}$;
 1.25A (5) (Use 3.3×1000) 3.3k Ω ; $3.3 \times 10^{-3} \text{ M}\Omega$ (6) (Use $.5 \times 10^3$) .5F; $.5 \times 10^{12} \text{ pF}$
 (7) (Use 2×1000) $2 \times 10^{-9} \text{ F}$; $2 \times 10^{-3} \mu\text{F}$ (8) $0.5 \times 10^{-3} \text{ H}$; $0.5 \times 10^3 \mu\text{H}$ (9) 3.4kW;
 $3.4 \times 10^6 \text{ mW}$; $3.4 \times 10^9 \mu\text{W}$ (10) $0.3 \times 10^3 \text{ msec}$; $0.3 \times 10^6 \mu\text{sec}$ (11) (Use 1.32×1000)
 1.32MHz; $1.32 \times 10^6 \text{ Hz}$ (12) $4 \times 10^3 \Omega$; $4 \times 10^{-3} \text{ M}\Omega$

CHANGING FORMULAS

F-1

You need to change formulas. Here are the patterns.



Ohm's Law: $I = V \div R$

_____ 1) Change to use fraction.

_____ 2) Find R (use $\frac{\div}{\div}$)

_____ 3) Find R (use fraction)

_____ 4) Find V

Time Formula: $T = \frac{1}{f}$

_____ 5) Change formula for $\frac{\div}{\div}$

_____ 6) Find f (use fraction)

_____ 7) Find f (use $\frac{\div}{\div}$)

Power Formula: $P = EI$

_____ 8) Find E (use $\frac{\div}{\div}$)

_____ 9) Find E (use fraction)

_____ 10) Find I (use $\frac{\div}{\div}$)

_____ 11) Find I (use fraction)

(1) $I = \frac{V}{R}$ (2) $R = V \div I$ (3) $R = \frac{V}{I}$ (4) $V = R \times I$ (or $I \times R$)

(5) $T = 1 \div f$ (6) $f = \frac{1}{T}$ (7) $f = 1 \div T$ (8) $E = P \div I$

(9) $E = \frac{P}{I}$ (10) $I = P \div E$ (11) $I = \frac{P}{E}$

ELECTRICAL POWER

F-2

Power: {rate of doing work or
rate of transforming energy from one form to another.

$$1) P = I^2 R$$

$$2) P = VI$$

$$3) P = V^2 \div R$$

P = power in watts (W)

I = current in amperes (A)

R = resistance in ohms (Ω)

V = potential in volts (V)

Remember:

$$I^2 = I \times I$$

$$V^2 = V \times V$$

Choose formula to fit your problem.

Worked below

- _____ 1) A toaster draws 5A when connected to 120V. How much power does it dissipate (use)?
- _____ 2) The potential across a 100 Ω resistor is 15V. How much power will the resistor dissipate?
- _____ 3) The current rating of a 1k resistor is 10mA. How much will the resistor dissipate at this current? (answer in mW)
- _____ 4) If a refrigerator draws 5 amperes when connected across 115 volts, what is the power dissipated by the system?

(1) Given A and V. Use formula #2

$$P = VI = 120V \times 5A = 600W$$

(2) Given Ω and V. Use #3

$$P = \frac{V^2}{R} = \frac{(15V)^2}{100\Omega} = \frac{225}{100}W = 2.25W$$

(3) Given Ω and A. Use #1

$$\begin{aligned} P &= I^2 R = (10mA)^2 \times 1k\Omega \\ &= (10mA \times 10mA) \times 1k\Omega \\ &= 10 \times 10^{-3} \times 10 \times 10^{-3} \times 10^3 W \text{ (want mW)} \\ &= 10 \times 10 \times 10^{-3} W = 100 \times 10^{-3} W \\ &= 100mW \end{aligned}$$

(4) Given A and V. Use #2

$$P = VI = 115V \times 5A = 575W$$

Ohm's Law

F-3

Ohm's Law: The current (I) through a resistance is directly* proportional to the voltage (V) across the resistance, and inversely proportional to the resistance (R).

$$I = \frac{V}{R} \quad \begin{cases} I = \text{current in amperes (A)} \\ V = \text{volts (V)} \\ R = \text{resistance in ohms } (\Omega) \end{cases}$$

Example: What is current through a 100 Ω resistor when 50V are used?

$$I = \frac{V}{R} = \frac{50V}{100\Omega} = .5A$$

Change formula when needed.

(worked below)

- _____ 1) A soldering iron has a resistance of 200 Ω and is connected to 120V. How much current is required?
- _____ 2) What is the resistance of a heating element if the current is 1.5A and the applied potential is 120V?
- _____ 3) The voltage across a 15k Ω resistor is 30V. What is the current through the resistor?
- _____ 4) What will the voltage drop across a 6.8k Ω be when 400mA flow through it? (answer in kV)
- _____ 5) The current through an unknown resistance is 0.25mA. The potential across the resistor is 3V, what is the unknown resistance?
- _____ 6) What will be the voltage across a 100k Ω resistor when the current through it is 50 μ A.

$$(1) I = \frac{V}{R} = \frac{120V}{200\Omega} = 0.6A \quad (2) R = \frac{V}{I} = \frac{120V}{1.5A} = 1.5 \overline{)120.0} \Omega = 80\Omega$$

$$(3) I = \frac{V}{R} = \frac{30V}{15 \times 10^3 \Omega} = \frac{30}{15} \times 10^{-3} A = 2 \times 10^{-3} A = 2mA$$

$$(4) V = IR = 400mA \times 6.8k\Omega = 400 \times 10^{-3} \times 6.8 \times 10^3 V \text{ (add powers)} \\ = 2720V = 2.72 \times 10^3 V = 2.72kV$$

$$(5) R = \frac{V}{I} = \frac{3V}{.25mA} = \frac{3V}{.25 \times 10^{-3} A} = \frac{3}{.25} \times 10^3 \Omega = 12 \times 10^3 \Omega = 12k\Omega$$

$\swarrow$ $\frac{3}{.25} = 12$ $\searrow$ $\frac{10^3}{10^{-3}} = 10^6$

$$(6) V = IR = 100k\Omega \times 50\mu A = \underbrace{10^2}_{100} \times 10^3 \times \underbrace{5 \times 10^{-6}}_{50} V = 5V$$

(add powers 2 + 3 + 1-6 = 0; 10⁰ = 1)

*directly proportional --> numerator
inversely proportional --> denominator

TIME AND FREQUENCY FORMULAS

F-4

Time (period): Time is inversely proportional* to the frequency ----> $T = \frac{1}{f}$

T = time for one cycle in seconds (sec)
f = frequency in hertz (Hz)

Examples:

What is the period of a 2kHz wave?

$$2\text{kHz} = 2 \times 10^3 \text{Hz}$$

$$T = \frac{1}{f} = \frac{1}{2 \times 10^3 \text{Hz}} = \frac{1}{2} \times 10^{-3} \text{sec} = .5 \text{ msec.}$$

The period of a waveform is 300 msec.
What is the frequency?

$$300 \text{ msec} = 3 \times 10^2 \times 10^{-3} \text{ sec} = 3 \times 10^{-1} \text{ sec}$$

$$f = \frac{1}{T} = \frac{1}{3 \times 10^{-1} \text{ sec}} = \frac{1}{3} \times 10 \text{ Hz} = .333 \times 10 \text{ Hz} = 3.33 \text{ Hz}$$

Note: Round off after 3 digits not zero.

Use time (period) and frequency formulas.

(worked on next page)

_____ 1) $f = 1\text{kHz}$, find T.

_____ 2) $f = 100\text{MHz}$, find T in nsec.

_____ 3) $f = 60\text{Hz}$, find T in msec.

_____ 4) What is the period of a 1kHz wave.

_____ 5) If $T = 33.3 \text{ msec}$, find f. (Hint: make $33.3 = .333 \times 10^2$; what is .333?)

_____ 6) If $T = 2.5\mu\text{sec}$, find f.

_____ 7) If $T = .0375\text{sec}$, find f.

_____ 8) What is the period of one MHz?

* If a is inversely proportional to b, then $a = \frac{1}{b}$

If a is directly proportional to b and inversely proportional to c, then $a = \frac{b}{c}$

TIME AND FREQUENCY PROBLEMS

1.	1kHz = 10^3 Hz	$T = \frac{1}{f} = \frac{1}{10^3\text{Hz}} = 10^{-3}\text{sec} = 1 \text{ msec}$	
2.	100MHz = $10^2 \times 10^6$ Hz	$T = \frac{1}{f} = \frac{1}{10^8\text{Hz}} = 10^{-8}\text{sec}$	$10^{-8}\text{sec} = \square \text{ nsec}$ $10^{-8} = \square 10^{-9}$ $10^{-8} \times 10^9 = \square$ $10 = \square$ Answer: 10 nsec
3.	60Hz	$T = \frac{1}{f} = \frac{1}{60\text{Hz}} = .0167\text{sec}$ $\uparrow$ round off .01666...	$.0167 \text{ sec} = \square \text{ msec}$ $167 \times 10^{-4} = \square 10^{-3}$ $167 \times 10^{-4} \times 10^3 = \square$ $167 \times 10^{-1} = 16.7 = \square$ answer = 16.7msec
4.	Period = T	Same as problem 1	
5.	$33.3 \text{ msec} = .333 \times 10^2\text{msec} = \frac{1}{3} \times 10^2 \times 10^{-3}\text{sec}$ $\uparrow$.333 is round-off for $\frac{1}{3}$	$f = \frac{1}{T} = \frac{1}{\frac{1}{3} \times 10^{-1}}\text{Hz} = \frac{1}{\frac{1}{3}} \times 10\text{Hz}$ (Note $\frac{1}{\frac{1}{3}} = 1 \div \frac{1}{3} = 1 \times \frac{3}{1} = 3$) $3 \times 10\text{Hz} = 30\text{Hz}$	
6.	$2.5\mu\text{sec} = 2.5 \times 10^{-6}$	$f = \frac{1}{T} = \frac{1}{2.5 \times 10^{-6}}\text{Hz} = \frac{1}{2.5} \times 10^6\text{Hz} = .4\text{MHz}$	
7.	$.0375\text{sec}$ $\uparrow$ can be changed to 375×10^4	$f = \frac{1}{T} = \frac{1}{.0375\text{sec}} =$ $\downarrow$ $.0375 \overline{) 1.0000} = 26.666\ldots$ use 3 digits in answer	$\rightarrow 26.7\text{Hz}$
8.	1MHz = 10^6 Hz	$T = \frac{1}{f} = \frac{1}{10^6\text{Hz}} = 10^{-6}\text{Hz} = 1 \mu \text{ sec}$	

What
is
T?

Note: T does not stand for seconds
 but second per cycle = $\frac{\text{sec}}{\text{cycle}}$
 Hz is cycle per second = $\frac{\text{cycle}}{\text{sec}}$
 Watch: $T = \frac{1}{\text{Hz}} = \frac{1}{\frac{\text{cycle}}{\text{sec}}} = 1 \div \frac{\text{cycle}}{\text{sec}} = 1 \times \frac{\text{sec}}{\text{cycle}} = \frac{\text{sec}}{\text{cycle}}$

We leave off cycle and write sec for T

SQUARE ROOT

P-1

_____ 1) $3^2 = \square$

_____ 2) $8^2 = \square$

In problems #1 and #2 we square a number - multiply a number by itself.

_____ 3) $\square^2 = 16$

_____ 4) $\square^2 = 49$

In #3 and #4 we are taking the square root - finding the number that was squared.

$\sqrt{\quad}$ is the square root sign. Example: $\sqrt{16} = \sqrt{4^2} = 4$

Use a calculator. Example: $\sqrt{16}$ --> Punch 16 then punch $\sqrt{x}$

5) Try $\sqrt{225}$ (Ans. 4)

Try $\sqrt{2}$ Note: The decimal answer will not repeat. This says there is no decimal number x itself equal exactly 2.

answer: 1.4142135 Watch this:

6) $(1.4)^2 = \underline{\hspace{2cm}}$

7) $(1.41)^2 = \underline{\hspace{2cm}}$

8) $(1.414)^2 = \underline{\hspace{2cm}}$

9) $(1.4142)^2 = \underline{\hspace{2cm}}$ (closer to 2)

_____ 10) $\sqrt{0}$

_____ 15) $\sqrt{1.44}$ 2 places - 1 in ans.

_____ 11) $\sqrt{1}$

_____ 16) $\sqrt{5.6169}$ 4 places - 2 in ans.

_____ 12) $\sqrt{2}$

_____ 17) $\sqrt{0.198025}$ 6 places - 3 in ans.

_____ 13) $\sqrt{3}$

_____ 18) $\sqrt{5}$ } Round to

_____ 14) $\sqrt{4}$

_____ 19) $\sqrt{6}$ } 6 places

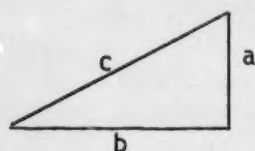
- (1) 9 (2) 64 (3) 4 (4) 7 (5) 15 (6) 1.96 (7) 1.9881 (8) 1.999396
 (9) 1.9999616 (10) 0 (11) 1 (12) 1.4142135 (more or less decimal places according to your calculator)
 (13) 1.7320508 (14) 2 (15) 1.2 (16) 2.37
 (17) 0.445 (18) 2.236068 (19) 2.449490

LENGTH OF SIDE OF RIGHT TRIANGLE

P-2

A right triangle has one square corner--> you can draw a square using 2 sides of the triangle.

Which are right triangles? Answer yes or no.



c the long side is called the hypotenuse
a the altitude
b the base

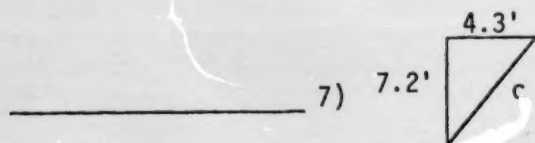
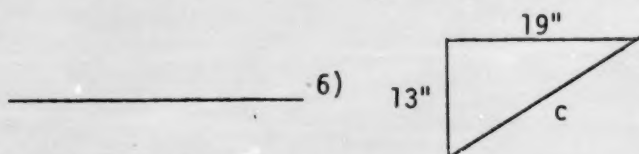
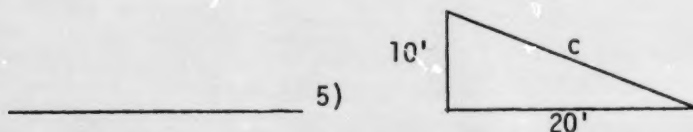
To find the length of c, use $a^2 + b^2 = c^2$
 $\sqrt{a^2 + b^2} = \sqrt{c^2}$
 so $\sqrt{a^2 + b^2} = c$

Steps

Example:  $a = 3$
 $b = 4$
 $c = ?$

- | | |
|---|----------------------------|
| 1) Square $a = a^2$ | 1) $3 \times 3 = 9$ |
| 2) Square $b = b^2$ | 2) $4 \times 4 = 16$ |
| 3) Add #1 and #2 = $a^2 + b^2$ | 3) $9 + 16 = 25$ |
| 4) Take square root of $\sqrt{a^2 + b^2} = c$ | 4) $\sqrt{25} = 5$ $c = 5$ |

Find c. (Round to two places) Be sure to write units on answer.



Steps for calculator:

- 1) Enter a; punch x^2
- 2) Write answer
- 3) Enter b; punch x^2
- 4) Punch +
- 5) Enter answer you wrote down
- 6) Punch $\sqrt{x}$

(1) yes  (2) No  (3) yes  (4) No  (5) 22.36 ft

(6) 23.02 inches (7) 8.39 ft

LENGTH OF OTHER SIDES OF RIGHT TRIANGLE

P-3

Find formula for base (b) of a right triangle.

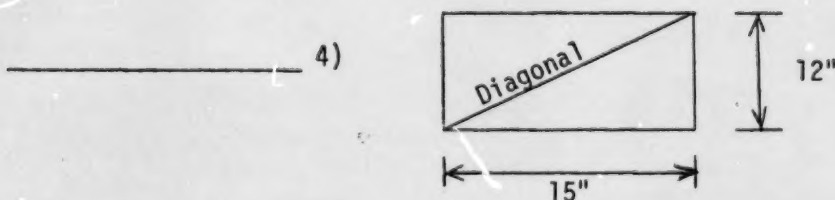
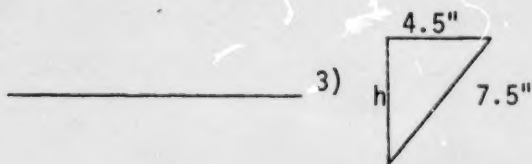
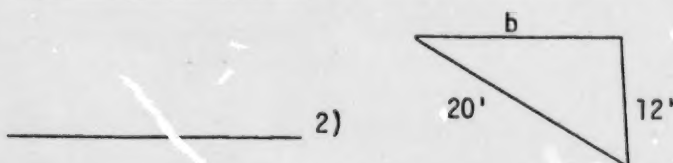
$$a^2 + \boxed{b^2} = c^2$$

$$\boxed{b^2} = c^2 - a^2$$

$$\text{If } b^2 = c^2 - a^2, \quad b = \sqrt{c^2 - a^2}$$

$$\text{Example: } a = 4, c = 5, \quad b = \sqrt{5^2 - 4^2} = \sqrt{25 - 16} = \sqrt{9} = 3$$

_____ 1) Write formula for a.



_____ 5) How far up the wall will a 20' ladder reach if its base is 8' from the wall? (Draw a picture.)

_____ 6) A square lot has a side length of 168 feet. What is the length of the diagonal? (Draw a picture)

Hint: $a^2 + a^2 = 2a^2$

(1) $\boxed{a^2} + b^2 = c^2$

$$\boxed{a^2} = c^2 - b^2$$

$$a = \sqrt{c^2 - b^2}$$

(4) diagonal is hypotenuse

$$\begin{aligned} c &= \sqrt{a^2 + b^2} \\ &= \sqrt{12^2 + 15^2} \\ &= 19.21 \text{ inches} \end{aligned}$$

(2) $b = \sqrt{20^2 - 12^2}$

$$= 16 \text{ ft}$$

(5) $\leftarrow \text{wall}$

$$a = \sqrt{20^2 - 8^2}$$

$$= 18.33 \text{ ft}$$

(3) $h = \sqrt{7.5^2 - 4.5^2}$

$$= 6 \text{ inches}$$

(6) square has sides equal $\boxed{a}$
diagonal is hypotenuse
a and b are equal.

$$\begin{aligned} c &= \sqrt{a^2 + a^2} = \sqrt{2a^2} = \sqrt{2 \times 168^2} \\ &= \sqrt{2 \times 28224} = 237.59 \text{ ft} \end{aligned}$$